



Environmental safeguards for industrial parks

William Avis
University of Birmingham
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Question

What approaches have been used to optimally enforce environmental policy instruments (i.e. standards/regulations, economic instruments and voluntary action by the private sector) to drive green industrialisation?

- *What are the key barriers/gaps in (e.g., designing standards/regulations; inspection and reporting; capacity and implementation, etc.) and enabling factors for enforcing government regulations and global norms in a developing country like Ethiopia?*
- *Consider any best practices, lessons learned, issues or opportunities from other countries that can inform discussion on how to enforce government regulations and global norms in a developing country like Ethiopia.*
- *For the industrial parks, specifically, identify/quantify the effects of using international benchmarks – whether driven by companies or Government regulations – on the local supply chains/manufacturers (particularly, those outside the industrial parks).*

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1. Overview

Industrial parks are planned and developed for the purpose of industrial and associated commercial, infrastructure, and service activities. By grouping firms in a specific location, industrial parks offer collaborative and efficiency gains. However, whilst industrial parks may contribute to economic growth and social development, parks can also cause negative environmental and social impacts including: climate change, pollution, resource depletion, labour issues, and attendant community disruption. Accordingly, there is much discussion locally and internationally as to how environmental safeguards can be designed and implemented.

Safeguard policies are tools to prevent or mitigate undue harm to people and their environment during the development process. In the context of industrial parks, these environmental safeguards define measures and processes to effectively manage risks and enhance positive impacts.

In developing and emerging countries there are numerous difficulties in enforcing environmental safeguards arising from lack of experience, lack of awareness and lack of regulations and their enforcement. Given the number of standards and demands for their application in different industrial park contexts as well as the differing capacities of park management, implementation can be challenging.

A lack of guidance, indicators and internationally agreed benchmarks presents a further challenge in directing prospective developers in the right direction, as well as in quantifying and communicating the benefits to firms of implementing environmental safeguards. Common barriers include:

- **Regulatory Barriers:** The lack of sufficient, appropriate and enforcement of regulations limits the push for traditional industrial parks and their resident businesses to transform their operations into sustainable production centres.
- **Technological and socio-economic barriers:** Certain high impact and innovative technological solutions are cost prohibitive to implement, especially in low margin environments and developing contexts. Competitive concerns can arise for firms in parks having to bear higher costs (due to higher environmental and social performance requirements) relative to those that do not, when both compete in the same markets.
- **Institutional and organisational capacity:** There are potentially a large number of internal barriers, one of the most important being technical capacity.

Despite these issues, industrial parks present a number of opportunities to support more sustainable industrial development. UNIDO, World Bank & GIZ (2017) argue that there is an opportunity to strategically plan and effectively manage industrial parks to help achieve the desired economic, social, and environmental targets. Efforts, led by UNIDO have seen the increased codification of guidance particularly in relation to developing Eco-industrial parks (EIPs). UNIDO (2017) assert that that a commonly agreed framework and set of indicators are needed to design and measure management and governance practices, social benefits, knowledge sharing efforts/results, and collaboration that lead to greater resilience and competitiveness.

International examples demonstrate that the successful implementation of environmental safeguards in industrial parks is dependent on the parks ability to compete and offer cost-effective and non-disruptive solutions to resident firms. The different indicators used to assess

the environmental and economic performance of industrial zones can be sorted into five main categories and can be grouped as follows: 1) land and population, 2) material consumption, 3) energy and emissions, 4) pollution, 5) administration and management.

Common across case study examples was the pivotal role played by park management. These bodies represented a hub that connect institutions, public authorities and partners. They offered guidance from conceptualising a business idea to its financing. Additionally, park management in the case study examples supported tenant companies in dealing with local authorities for purposes of applying and obtaining operating permits and other issues.

Park management bodies were often led by an advisory board composed of representatives from the local government, academia and industry. It is noted that in developing country contexts, ongoing support is needed to scale-up park management capacity through dedicated training sessions, expert group meetings and study tours. Attention is also needed to support park businesses in developing their capacity to address environmental issues and meet safeguarding requirements. This can be supported by establishing connections beyond park boundaries with vocational schools in neighbouring areas. This collaboration may be particularly beneficial in ensuring the recruitment and retention of highly-skilled labour. Park management bodies can also support the creation of business networks, the operation of conference and event facilities, and coordinating joint media efforts for companies and the industrial park. This can support parks and firms address issues of industrial development and environmental and social sustainability by collaborating with academia and joining dialogue platforms with businesses.

2. Environmental safeguards for industrial parks

Industrial parks (also referred to as industrial areas, industrial zones, industrial investment regions, special economic zones, industrial corridors etc.) are planned and developed for the purpose of industrial and associated commercial, infrastructure, and service activities. By grouping industrial firms in a specific location, industrial parks offer potential collaborative and efficiency gains. The World Bank (2014: 7) comments that the rationale for industrial parks has traditionally been:

- First, the provision of functional infrastructure is easier to plan in a geographically limited space, particularly for delivery constrained governments.
- Second, the concentration of firms can provide significant spill over effects both inside and outside the park: information spill overs, including knowledge and technology; the specialisation and division of labour among enterprises; the development of skilled labour markets; and the development of markets around the parks.

In a similar vein, UNIDO (2017) suggest that industrial parks in emerging and developing countries can provide an institutional framework, modern services and a physical and often social infrastructure, which might not be available in the rest of the country. The concentration of companies can foster innovation, technological learning and company growth. Economies of scale of the supply of services and facilities reduce the costs for companies, thus successful industrial parks can contribute to high growth regions and national economic development.

However, whilst industrial parks can serve in contributing to economic growth and social development of a country or a region, such parks can also cause negative environmental and social impacts including: climate change, pollution, resource depletion, labour issues, and

attendant community disruption (UNIDO, World Bank & GIZ, 2017). UNIDO (2017) note the economic gains stemming from the creation of industrial parks may come at a loss of environmental quality within and around industrial estates. Historic examples gleaned from Chinese and South Korean experience certainly highlight this potential. In the latter, the Global Green Growth Initiative (2017: 6) report that in Ulsan, pollutants from industrial zones severely contaminated air and water, making Ulsan one of the most unliveable areas in South Korea.

More broadly, criticisms of various kinds of industrial parks have depicted these as a controversial development models based on fiscal incentives and export requirements. Certain programs have been criticised for eroding the tax base; creating vehicles for land speculation; delivering hand-outs to favoured firms; and funnelling finance to favoured districts (World Bank, 2014). Further to this, UNIDO (2017) assert that sustainable business practices have been largely ignored or overlooked by enterprises operating in such zones.

The performance failures of industrial parks (including failure to implement and enforce environmental safeguards) can often be traced to the initial planning, building and operation of such parks, the stakeholders involved and the functions they have been assigned. Steps in the process of establishing or developing an industrial park can be broadly outlined as (World Bank, 2014):

- identification of park location;
- identification of potential demand and overall dimensions;
- procurement of land;
- design and dimensioning (“master planning”) within the park;
- financing and financial structuring and planning;
- procurement of infrastructure building;
- construction of infrastructure;
- operation & maintenance; and
- monitoring and evaluation.

Ensuring the implementation and enforcement of environmental safeguards is required throughout each of these stages. However, this is not a model which can be understood simply. Its performance is not uni-causal and its features are complex and deeply related to context, in particular its local political economy, industry structures and firm capabilities (World Bank, 2014).

Despite these challenges, industrial parks present a number of opportunities to support more sustainable industrial development. UNIDO, World Bank & GIZ (2017) argue that there is an opportunity to strategically plan and effectively manage industrial parks to help achieve the desired economic, social, and environmental targets.

Underlying support for the implementation of environmental safeguards in industrial parks is a belief that a positive net economic effect accompanies many environmental investments and services because they make manufacturing more efficient, i.e. decrease waste, energy efficiency and loss of materials. They also lower the costs of environmental compliance. It is asserted that where benefits are properly shared between the park management and its tenant companies, all parties can benefit (Europe and Central Asia Regional Conference on industrial parks, 2012).

The concept of eco-industrial parks (EIPs) is particularly salient for this report i.e. industrial parks in which companies cooperate with each other and with the local community trying to reduce waste and pollution, efficiently share resources and help to achieve sustainable development, with the intention to augment economic gains and improve environmental quality. Various definitions of EIPs are mobilised, with that articulated by Lowe (1997) referenced by many international organisations:

“A community of manufacturing and service businesses located together on a common property. Member businesses seek enhanced environmental, economic, and social performance through collaboration in managing environmental and resource issues. By working together, the community of businesses seeks a collective benefit that is greater than the sum of individual benefits each company would realise by only optimising its individual performance.”

Although the EIP concept is well established, critics have commented on the lack of a conceptual clarity pertaining to the concept. UNIDO, World Bank and GIZ (2017) have sought to develop a common understanding of EIPs. Whilst they note that strict guidelines would be impractical due to varying country conditions and industrial park frameworks, adapting a set of common parameters to different local contexts could increase the sustainability of industrial development and enhance the credibility of EIP. With this framework, policymakers and park operators are encouraged to take the following steps (Demir et al., 2018):

- Rely on a detailed technical and financial analysis that helps build the business case for eco-industrial parks: Detailed technical and financial analysis should be conducted while executing the EIP Framework to provide evidence that beyond an economic rate of return, there is a clear business case for these industrial parks to convert to an EIP.
- Ensure regulations match EIP ambitions: Beyond financial viability, countries may have regulatory frameworks that may limit or hinder certain actions within EIPs. Countries need to ensure that their regulations and institutions facilitate and support these EIP actions.
- Nurture and monitor the EIP framework: Countries should transparently update and modify the framework to ensure there is gradual improvement of performance of EIPs and that lagging EIPs are given a chance to catch up.
- Leverage public-private dialogue: Industrial parks require a wide range of collaboration across national and private actors. EIPs make this an even more ambitious undertaking requiring a wider range of actors dealing with environment, energy, labour, and other related issues. The public and private sectors must take active steps to promote industrial development in an environmentally-sustainable manner. Proceeding with a more robust framework of what an EIP entails should build confidence that our aspirations for environmentally sustainable growth are attainable.

Drivers of environmental safeguards for industrial parks

As environmental externalities become an increasingly significant factor in business operations and decision-making, UNIDO, World Bank & GIZ (2017) assert that there will continue to be an increase in trends for the development of environmental safeguards for industrial zones and particularly the development of EIPs. Further to this, with a growing global population, resources are under pressure. Industries may become less competitive due to increasing resource scarcity coupled with high and volatile energy costs. To curb these impacts and ensure productivity of

industries in resource-scarce environments, governments are looking to scale up resource efficiency and cleaner production practices by promoting resource efficiency (UNIDO, 2017).

Climate change and the Paris Agreements have signalled a shift in how climate change is prioritised. Drives to finalise the agreements' National Determined Contributions, National Adaptation Programs of Action, National Appropriate Mitigation Actions, and related actions has highlighted the active role that industries play in supporting the climate actions of national governments and global supply chains. World Bank (2016) continue that driving factors will include such things as a common price on carbon and national commitments to mitigation and adaptation and implementation of such measures.

The trend toward sustainable and climate friendly products has also increased (World Bank, 2016). There is now awareness that sustainability and climate change actions along the supply chain are necessary to tackle climate change challenges. This trend has been accompanied by a visible shift in the procurement preferences of the global buyers (for example Ikea) to whom industrial park enterprises often cater. The World Bank (2016: 11) identifies drivers for the adoption of environmental safeguards in industrial parks as follows:

- Demands for more sustainably sourced and produced products.
- A desire for zone developers and operators to provide additional services to tenants and differentiate themselves from other types of industrial land.
- Growing pressure from external stakeholders such as the government, regulators, NGOs, and CSOs forcing parks to operate in an environmentally responsible fashion.
- Voluntary action by industry to self-regulate and increased focus on practical corporate social responsibility efforts.

These, among other factors, have created a demand for further knowledge and information on environmental safeguards and how to support the development of EIPs. While these drivers have contributed to a shift in industrial park management trends, it is important to note that profitability and financial viability often remain a park management and company's main objectives.

Guidelines for environmental safeguards in industrial parks

A number of applicable international standards, conventions, and protocols are currently in existence that have some relevance for the application of environmental safeguards in industrial parks. These include among others:

- Stockholm Convention on Persistent Organic Pollutants (<http://chm.pops.int/>);
- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes(<http://www.basel.int/TheConvention/Overview/tabid/1271/Default.aspx>);
- Vienna Convention for the Protection of the Ozone Layer (<http://ozone.unep.org/en/treaties-and-decisions/vienna-convention-protection-ozone-layer>);
- Emission Thresholds from the World Health Organisation (<http://www.who.int/mediacentre/factsheets/fs313/en/>);
- International Convention for the Prevention of Pollution from Ships ([http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-\(MARPOL\).aspx](http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx));

- IFC Environmental, Health and Safety (EHS) Guidelines and Performance Standards (https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines);
- Montreal Protocol on Substances that Deplete the Ozone Layer (<http://ozone.unep.org/en/treaties-and-decisions/montreal-protocol-substances-deplete-ozone-layer>);
- Economic Commission for Europe (ECE) Water Convention on the Protection and Use of Transboundary Water Courses and Internal Lakes (<https://www.unece.org/fileadmin/DAM/env/water/pdf/watercon.pdf>);
- Ramsar Convention of Wetlands (<https://www.ramsar.org/>);
- Food and Agriculture Organization (FAO) International Code of Conduct on the Distribution and Use of Pesticides (<http://www.fao.org/docrep/005/Y4544E/y4544e00.htm>);
- World Health Organization (WHO) Recommended Classifications of Pesticides by Hazard Class Ia/Ib (http://www.who.int/ipcs/publications/pesticides_hazard/en/);
- Espoo Convention on Environmental Impact Assessment in the Transboundary Context (<https://www.unece.org/env/eia/welcome.html>).

The Asian Development Bank (ADB, 2012) have also compiled a sourcebook of environmental safeguards. The Sourcebook is based on ADB's experience in environmental assessment and management, and international good practices adopted by other multilateral development banks. Similarly, the World Bank Group have developed an exhaustive list of Environmental, Health and Safety Guidelines and technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP). ¹

Given the number of standards and demands for their application in different industrial park contexts as well as the differing capacities of park management, implementation can be challenging. Further to this, despite reference to Lowe's (1997) definition of EIP's, there is much debate as to what constitutes an EIP, how one can be established and supported and how best to enforce environmental safeguards in such areas. Such definitional ambiguity have led to World Bank (2016) concluding that the current global framework for EIPs and lack of standards delay trust in the concept and prevent the EIP "brand" from being a market driver.

A lack of guidance, indicators and internationally agreed benchmarks present a challenge in directing prospective developers in the right direction, as well as in quantifying and communicating the benefits to firms of implementing environmental safeguards in industrial parks. Efforts, led by UNIDO have seen the increased codification of guidance. UNIDO (2017) assert that that a commonly agreed framework and set of indicators are needed to design and measure management and governance practices, social benefits, knowledge sharing efforts/results, and collaboration that lead to greater resilience and competitiveness. To support the development of environmental safeguards in industrial parks, World Bank (2016) comment that the international community and industrial park investors need to take the initiative to develop a common understanding of EIPs and their technical requirements. Further, this needs

¹ https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines

to be complemented by national frameworks that are supportive and committed to implementing good industrial practices and environmental regulations to form a baseline for EIP growth.

One attempt to support both countries and industries is UNIDO's Resource Efficient and Cleaner Production (RECP) method. This approach entails the continuous application of preventive environmental strategies to processes, products and services in order to increase efficiency and reduce risks to humans and the environment. Convened by UNIDO and UNEP, the Global Network for Resource Efficient and Cleaner Production (RECP^{net})² brings together leading RECP service providers on a global and regional level to catalyse the effective and widespread application of RECP in developing and transition economies. It does so by offering specialised, high-quality technical and advisory services to industries, capitalizing on synergies between its members and working to continuously improve their capacities.

Arriving at globally agreed norms is, however, challenging given that the activities and regulatory environments that define national governance legislation, regulations and structures for industrial parks vary considerably across countries. GIZ (2015) have developed a series of guidelines to support the development of Sustainable Industrial Areas focused on the management level of an industrial zone or park. Whilst they intend to guide the industrial area as a whole to become more sustainable, these guidelines include clear reference to how environmental safeguards can be developed and enforced. These are further developed by UNIDO, World Bank and GIZ (2017) framework.

This innovative approach suggest a set of "minimum requirements" or "sustainability performance standards" for industrial parks, covering legal compliance as well as socio-economic, environmental, and management aspects. Such standards provide benchmarks for assessing existing industrial parks, planning retrofitting measures for existing parks, or better planning new industrial parks with the end goal of driving inclusive and sustainable industrialisation (GIZ, 2015: 6-12). Features are paraphrased in the following with environmental safeguards cross cutting each element:

Organisational features

- **Site Master Planning:** The successful implementation of a sustainable industrial area requires a holistic and detailed planning process that considers equally environmental, social and economic issues from the outset.
- **Management Structure:** For an industrial area considered to be well managed, well organised and prepared to implement sustainability measures, a management structure is required. This structure needs to be endowed with clear mandates, an adequate budget line and should be in the position to define by-laws compulsory inside the industrial park (e.g. park charter, corporate social responsibility charter, environmental, occupational health and safety, social standards, etc.). Enforcement of such rules must be monitored (e.g. by Key Performance Indicators).
- **Service Orientation:** Management units of sustainable industrial areas should regard themselves as service providers rather than as administrative units. This needs a clear understanding about the needs of the customers who are primarily the resident

² <http://www.recpnet.org/kms-documents/>

companies inside the industrial areas but also the municipal and state-level administration and the surrounding industry and population.

- **Networking & Cooperation:** Networking is a key element to achieve sustainability. Firstly, inside the industrial area, where the park management initiates a closer cooperation among the companies to enable synergies in doing business together (e.g. obtain contracts at large scale or joint procurement on better terms), in exchanging knowledge on energy and resource efficiency, and in fostering the exchange of services, materials, energy and by-products. Secondly, the park management develops business networks with companies outside the park, upstream and downstream, in order to optimise sales or purchasing conditions. And thirdly, it supports the participation of the neighbouring community.
- **Participation in Planning and Operation:** A good planning process is one cornerstone of a sustainable industrial area. Ideally, sustainability criteria are included from the start during master planning and all following planning steps. Besides considering economic and environmental aspect, social participation within the park and between the park and the local population is key.
- **Maintenance, Cleaning, Retrofitting:** In a sustainable industrial area processes have to be developed and mechanisms put in place to maintain the industrial park, which includes cleaning, infrastructure up-keeping and modernising/retrofitting infrastructure. The cleaning and up-keeping services are usually financed by the companies in the area which pay a respective fee to the management unit. The same applies for large scale retrofitting measures. Under certain circumstances, governmental funding or co-funding for retrofitting measures to promote certain industries or regions can be eligible as well.
- **Disaster Risk Management:** The management unit of the industrial area needs to take precautions for two types of risks, risks related to the operation of the industrial area and natural risks. It is the responsibility of the management to implement measures for prevention and management of all emergencies which result from industrial activities (e.g. explosions, fires in chemical processes, adequate and comprehensive transport and storage of dangerous goods, release of hazardous substances). Additionally, the management needs to be prepared for those risks that are not directly related to the operations on site, such as natural disasters (e.g. earthquakes, avalanches, storms, flooding, and land - slides).

Economic and Infrastructure Features

- **Economic Viability of Management and Site Management:** This requires a business plan, which brings forecasted expenditures and revenues into balance. Revenues are expected from selling and renting the plots, from monthly operating/service fees paid by resident companies and governmental funds for providing housing, education, health or other services to the community. The income has to cover costs for the management of the park, provision of services and taxes paid to the government if profits are achieved.
- **Fiscal Effects on the Municipality:** An industrial site should create positive effects for the municipality or community it is located in as well as for the entire economic region. Successful parks are able to influence the regional economic development positively by initiating new supply and product chains and increased economic activities.
- **Infrastructure Provision and Logistics in General:** Within the industrial area, infrastructure provision and management is the most obvious role of a park operator.

However, operators of industrial sites often tend to restrict themselves to the building of roads and the provision of energy and water. However, modern industrial areas have a more holistic approach and take care of all aspects of infrastructure and logistics, supply of energy, water and goods, collection and treatment of effluents and waste as well as provision of communication networks.

- **Energy Generation and Distribution:** Energy supply and distribution needs to be based on an integrated system of incoming energy from outside the industrial area and energy generation inside the area. The management company may buy energy in large quantities from external suppliers or generate energy internally from conventional fuels, renewable energy sources and waste or utilise waste energy, heat and steam coming from the resident companies. This requires an integrated electricity, gas and steam distribution network operated by a single entity, ideally the management unit itself.
- **Waste Management:** Waste management in sustainable industrial areas should follow the principles of the waste management hierarchy which gives avoidance of waste, reuse, recycling and conversion into energy priority to incineration and disposal. In order to set up such a system, the park management needs to offer advice on how to prevent, minimise and separate the waste within the companies. Furthermore it provides joint service facilities at park level for the collection, sorting, treatment, recycling and disposal of the different types of waste including those which are hazardous.
- **Water and Wastewater Management:** The scarce resource water should be attended to a holistic water and wastewater management approach. Responding to the different qualities of drinking and process water needed in the park, the management must be able to offer several water qualities, ideally in a cascading way based on re-use concepts to save water. An analysis of the water distribution system constitutes the basis for identifying the requirements of the industry and existing water saving potentials. Advice and support to reduce water consumption and reuse wastewater is given to companies to raise awareness in the industry. Rainwater harvesting should be practiced on park facilities and the collected water should be made available (after conditioning) to the companies for production purposes.
- **Transport system:** Inside the industrial area transport of goods and passengers has to be provided. While the transport of goods is mainly organised by the companies themselves or given to private logistic companies, passenger transport of staff and customers to and inside the area requires the attention of the management unit. Sufficient integration into a public transport system is often not the case.

Environmental Features

- **Knowledge about/application of environmental standards, enhanced environmental protection:** A prominent task of the management unit of the industrial area is to help endorse respective laws and regulations and introduce on-site rules. For that purpose, management should provide detailed information about existing environmental laws and environmental standards, both international and national and give advice on their application in the park, e.g. by informing companies in seminars or training staff of the companies. Examples of best practices should be collected and tested regarding their applicability in the park. Rewarding good examples of on-site companies for the most sustainable/environmental-friendly practices help to improve the environmental protection.

- **Promotion of Resource Efficiency and Industrial Symbiosis:** It is the task of the management of an industrial area to promote resource efficiency. It should give advice on the topic and support the effort of companies to increase their resource efficiency. In offering training and carrying out company audits possible areas for improvement are identified. Advice on resource efficient technologies and process concepts will enable the companies in the park to increase their resource efficiency. The park management itself should also become a model in providing a resource efficient infrastructure and using their own resource efficient low-energy buildings.
- **Monitoring and Control of Emissions:** To maintain and enforce the environmental targets of the park, the park management needs to monitor emissions. Besides air borne emissions like partials, aerosols, gases and odour also noise and light should be registered. Measurements should take place at individual workplaces (important for occupational health and safety), at emitting sources on company premises (e.g. stacks; verification of allowed emission limits) and open spaces within the park area (measuring the ambient pollution of the industrial area). These measurements are carried out sporadically, in regular intervals or continuously. They can be carried out by the companies themselves, the park management, government authorities or contracted environmental labs.
- **Groundwater and Soil Protection:** Industrial areas consume land and bear risks of polluting the used land. Pollution of the soil and subsequently the groundwater resources can occur through the leakage of fuel, production liquids or wastewater. Other sources of pollution are dumping of waste or other types of solid residues of production processes. It is the duty of the management unit of the industrial area to monitor the compliance of the companies with the respective laws and in their absence to set compulsory rules for the operations on their site to prevent soil and groundwater pollution.
- **Promotion of Biodiversity:** As the economic performance of businesses depends on functioning ecosystem services, for instance regarding water supply for the production process and fresh air for employees' health and productivity, aspects of biodiversity should be a central feature of site master planning as well as of the park's code of conduct. In doing so, functioning ecosystems and biodiversity will be preserved while business risks, for instance with regard to climate change impacts, like water shortages and heat waves, will be mitigated.
- **Efficient Land Use:** During master planning of new industrial areas concepts for efficient land use have to be developed. These concepts take the existing local land use planning into account and make use of the provided space in a sensible manner. If a local land use plan does not exist, other strategic government documents and the already existing infrastructure have to be taken into account.
- **Climate Change Mitigation and Adaptation:** To achieve sustainability of industrial parks the issues of climate change mitigation and adaptation can no longer be neglected. While the reduction of greenhouse gases goes in line with measures to increase energy and resource efficiency, adaptation is required to maintain long term operability under changing climate conditions.

Social Features

- **Social Infrastructure:** Social infrastructure addresses different aspects to improve the living and working conditions of the employees, as well as of the neighbouring

communities. Needs of employees might vary depending on the sector and country. It also makes a difference if employees commute every day into the industrial area or live inside it. While some sites are pure industrial areas, others have to be regarded as communal development zones with a wide spectrum of facilities and activities.

- **Promotion of Lodging Standards:** For large industrial areas and in particular for mixed-use zones the provision of accommodation for workers and employees within or close to the industrial area should be considered. This reduces the needs for transport and shortens the travelling time of workers to their workplace. Some production sites also require seasonal work forces which typically do not have permanent houses in the vicinity. Moreover diverging accommodation needs for truck drivers, visitors and other clients need to be considered. To guarantee that lodging facilities are acceptable, housing standards have to be defined and should be monitored by park management.
- **Security Concept:** A security concept is crucial for both the personal security of the employees and the security of the companies against burglary. In a closed industrial area security can be achieved in limiting the access points of the park which are constantly under surveillance. Within the park good lighting, camera surveillance, emergency phones and patrolling security personnel are key elements to enhance security.
- **Promotion of Working and Occupational Health Standards:** The promotion of working and occupational health standards in the industrial area addresses health and safety at the workplace itself. It comprises aspects such as workplace comfort regarding air quality, visual comfort, noise protection and an appropriate work-rest balance. Regular medical check-ups of workers and employees, provision of safety gear (protective goggles, gloves, safety shoes, filter masks, etc.), monitoring of exposure limits and safety trainings are important measures to increase occupational health and safety.
- **Promotion of Gender Equality:** Although often a large part of the workforce of an industrial area, parks do not care sufficiently about the specific needs of women. Ignorance exists for example regarding their needs for separate toilets and washing facilities, their various roles as worker, housewife and mother, their vulnerability in respect to security or their different requirements as business women or entrepreneurs.
- **Encouragement of Trade Unions and NGOs:** Transparency is an important attribute of a sustainable industrial area. It includes not only the information of everybody inside and outside of the park regarding the future development or possible environmental risks but also intends to promote civil society and the activities of its institutions in the industrial area. While trade unions in particular take care of the workers' rights and are an important factor for better working conditions, NGOs and other civil society organisations will address more general environmental, social and even political issues.

Barriers/gaps in enforcing government regulations and global norms

Whilst the above provides a clear steer as to how environmental safeguards can be designed and implemented, a number of barriers exist in designing and implementing environmental safeguards for new as well as existing parks. The type and severity of barriers varies across different industrial parks. According to the World Bank (2016), those tasked with implementing environmental safeguards in existing parks are faced with the challenge of enforcing regulations in contexts where complex processes and existing infrastructure are already operational which can present technical design, installation, and operational challenges for ensuring the application

of environmental safeguards. Accordingly, stakeholders must tailor or phase the implementation and enforcement of regulation within parks to ensure the barriers faced can be overcome.

In contexts of implementing and enforcing environmental safeguards in new parks, this will likely require time allocation, expenditure in planning and designing regulations, and ensuring the development of monitoring and evaluation capabilities. The World Bank (2016) suggests that, this can be supported from the outset through detailed front-end engineering design phases, which can allow for the integration of the most efficient and cost-effective design, as well as the adoption of eco-efficient processes and embedding of commitment to regulations.

There are currently a number of complementary tools and processes to assist governments and industrial park stakeholders to progress in the implementation of inclusive and sustainable industrial development. However, a consolidated and targeted framework for EIPs is largely lacking at the international level and there is still no consolidated and internationally accepted criteria or performance indicators for what constitutes an EIP (UNIDO, World Bank and GIZ, 2017). Consolidated and targeted guidelines for environmental safeguards are thus largely lacking stemming from a number of factors (UNIDO, World Bank, GIZ, 2017: 16).

- Divergence in name and understanding: The EIP concept can mean different things to different parties. While similarities exist across the breadth of literature, stakeholders require a clear and consistent designation from the international community;
- Practice does not yet match ambition: Some parks describe themselves as an EIP, but fall short in performance. For instance, they may not be continuously implementing environmental and social improvements;
- There is potential to leverage best-in-class examples: Many good practice elements exist, but these need to be brought together and implemented routinely in the planning, development, and management of industrial parks;
- Barriers and market failures still exist: Lack of experience, awareness, and supporting regulations, as well as enforcement, slow the development and implementation of EIPs.

In developing and emerging countries there are many difficulties arising from lack of experience, lack of awareness and lack of regulations and its enforcement. Below are some examples of common barriers:

Table 1: Key barriers for EIPs and potential solutions (Source UNIDO, World Bank & GIZ: 25).

Regulatory Barriers: The lack of sufficient, appropriate and enforcement of regulations limits the push for traditional industrial parks and their resident businesses to transform their operations into sustainable production centres.

Barriers	Sample Solutions
Lack of suitable policies to encourage EIP development (both command and control, and fiscal incentives).	Seek to understand the key national and local barriers to the adoption of environmental and social standards in industrial operations.
Lack of policies to encourage clean technology development and adoption.	Set hard and soft targets for the development of EIPs.

Lack of transparency surrounding industrial regulations and enforcement.	Develop command and control, and fiscal incentives that encourage EIPs.
Regulations are not universally applied, leading to competitive disadvantages.	Develop regulations that are conducive to the development of an enabling environment for EIPs.
Limited ability of stakeholders to transpose privileged regulatory frameworks into industrial parks.	Engage in national, regional, and international dialogue to source best practices, rather than duplicate existing practices.

Technological and socio-economic barriers: Certain high impact and innovative technological solutions are not advanced enough, and/or are cost prohibitive to implement — especially in low margin environments and developing contexts. Competitive concerns can arise for firms in parks having to bear higher costs (due to higher environmental and social performance requirements) relative to those that do not, when both compete in the same markets.

<p>Barriers:</p> <p>Park management entity and enterprises lack financing to implement pollution prevention mechanisms.</p> <p>High upfront capital costs with long returns on investment prospects limit implementation.</p> <p>Limited financial support for innovative processes and environmental measures from the park to resident enterprises.</p> <p>Park management is not entrusted with clear and appropriate mandates and budgets.</p> <p>Long lead times and disruptions in installing new technologies.</p> <p>Limited understanding of the benefits of socially responsible business practices.</p> <p>Lack of research funding.</p>	<p>Sample Solutions:</p> <p>Policy makers can: Provide capital subsidies and technical assistance to assist with the implementation of new technologies.</p> <p>Encourage technological cooperation programs.</p> <p>Promote mechanisms to encourage standardization.</p> <p>Promote socially responsible business practices.</p> <p>EIPs can: Engage in park-level dialogue and enterprise training to improve awareness of the most cost effective and advanced technology solutions and socially responsible business practices and associated benefits.</p> <p>Deploy outsourced, technically sound infrastructure and services through viable business models.</p>
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Institutional and organisational capacity: There are potentially a large number of internal barriers, one of the most important being technical capacity

<p>Barriers</p> <p>Lack of internal resources and technical workforce.</p> <p>Lack of motivation across resident businesses for continuous improvements in moving toward an EIP.</p> <p>Lack of experience and awareness of developers and authorities.</p> <p>Lack of capabilities for energy conservation and pollution prevention.</p>	<p>Example Solutions:</p> <p>Policy makers can: Prepare national guidelines and standards for EIPs. The standards suggested here can help inform frameworks and serve as a benchmark.</p> <p>Fund training programs.</p> <p>EIPs can: Examine sector-specific international best practices and replicate them across the parks.</p>
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Lack of stakeholder communication channels.	Develop internal training programs to build human resource capacities, which in turn can provide a competitive advantage.
Lack of management resources.	
Lack of indicators and guidelines.	Engage with national and regional stakeholders to build external capacity and confidence in EIPs.
More pressing priorities than environment, safety, and social cohesiveness.	Engage competent professionals and/or qualified companies in undertaking EIP assessments, site master planning, and so on.
Lack of external support from owners, value chains, communities and international organizations.	

3. Governance and management of eco-industrial parks

It is important to make a distinction between the governance and management of industrial parks. The governance of an industrial park deals with the setting of rules and standards as well as the monitoring of their implementation (with an option for sanctions in case of non-compliance) (UNIDO, 2016). This is particularly pertinent when considering the implementation and enforcement of environmental safeguards. Management is more narrowly concerned with planning, implementing and operating an industrial estate though still pertinent to the implementation of environmental safeguards.

In a global assessment of EIPs, UNIDO (2016) concluded that information regarding the governance mechanisms and setting of rules and standards for surveyed EIPs was limited and therefore did not allow for a substantive analysis. However, information on the monitoring was more accessible.

UNIDO (2016) reported that circa half of the industrial parks surveyed monitoring their performance and the other half were committed to ensuring monitoring responsibilities in future, subject to new regulations coming in place. Monitoring of park performance is considered a condition to be able to track progress against identified goals and set standards and hence demonstrate environmental, economic and social outcomes in an efficient, transparent and accountable manner. Monitoring is a prerequisite for good environmental management. A successful EIP must have monitoring to be able to assess the differences in indicators before and after the measures.

Case Studies

International examples demonstrate that the successful implementation of environmental safeguards in industrial parks is dependent on the parks ability to compete and offer cost-effective and non-disruptive solutions to resident firms. For example, the lack of access to competitively priced water, energy, and raw materials, as well as the risk of disrupting operations to accommodate innovative low carbon technologies and process improvements, can be potential barriers to firms establishing and operating environmental safeguards in industrial parks. In what follows I provide a number of case studies of efforts to implement or enforce environmental safeguards in industrial parks at both the national and local level, these touch on the governance and management structures and processes that may prove supportive of developing, implementing and enforcing environmental safeguards.

Chinese Eco-Industrial Park Standards and Certifications, China (IISD, 2015)

In China, the industrial sector is responsible for circa 70% of energy consumption and 72% of carbon emissions. The industrial sector is therefore of central importance for achieving carbon emission intensity targets as identified in a 2009 State Council declaration (a 40-45 % reduction by 2020 based on 2005 levels) and in the 12th FYP (a 17% reduction between 2011-2015). However, carbon emissions are not the only constraints that Chinese industry is facing. Indeed, the growing scarcity of natural resources necessitates increased resource efficiency, including improving its reuse and recycling rates.

To address these concerns (carbon emissions, natural resource scarcity and pollution), Chinese authorities set up three pilot programs for industrial parks: the Eco-Industrial Park Demonstration Program led by the Ministry of Environmental Protection (MEP); the Circular Transformation of Industrial Parks led by the National Development and Reform Committee (NDRC) and the Ministry of Finance (MoF); and the Low-Carbon Industrial Park Program led by the Ministry of Industry and Information Technology (MIIT). While not identical, these programs share the aim to reduce the environmental impact of Chinese industry and to increase its competitiveness:

- **The EIP Demonstration Program** was initiated at the end of the 1990s by the MEP and has been accelerated in recent years. The aim of an EIP is to minimise waste generation and improve the overall eco-efficiency of parks by applying principles such as industrial symbiosis, clean production, green supply chain management and centralised pollution abatement. While legislation does not exclude the possibility of building new EIPs, the policies are focused on the improvement and certification of existing industrial parks.

Figure 1: Metrics in the standards for sector integrated eco-industrial parks (Source: IISD, 2015: 6)

CATEGORY	METRICS		UNIT	VALUE
Economic development	1.1	IAV per capita	104 RMB/P	≥ 15
Material reduction and recycling	2.1	IAV per industrial land occupancy	100 million/km ²	≥ 9
	2.2	Energy consumption per IAV	tce/10 ⁴ RMB	≤ 0.5
	2.3	Coefficient of elasticity on energy consumption	--	< 0.6
	2.4	Fresh water consumption per IAV	m ³ /10 ⁴ RMB	≤ 9
	2.5	Coefficient of elasticity on fresh water consumption	--	< 0.55
	2.6	Industrial wastewater generation per IAV	ton/10 ⁴ RMB	≤ 8
	2.7	Solid waste generation per IAV	ton/10 ⁴ RMB	≤ 0.1
	2.8	Industrial water reuse ratio	%	≥ 75
	2.9	Solid waste reuse ratio	%	≥ 85
Pollution control	3.1	Chemical Oxygen Demand (COD) emission per IAV	kg/10 ⁴ yuan	≤ 1
	3.2	Coefficient of elasticity on COD emission	--	< 0.3
	3.3	Sulphur dioxide (SO ₂) emission per IAV	kg/10 ⁴ yuan	≤ 1
	3.4	Coefficient of elasticity on SO ₂ emission	--	< 0.2
	3.5	Disposal rate of hazard solid waste	%	100
	3.6	Centrally provided treatment rate of domestic wastewater	%	≥ 85
	3.7	Safe treatment rate of domestic rubbish	%	100
	3.8	Waste collection and disposal system	--	available
Administration and management	4.0	Extent of establishment of information platform	--	established
	4.1	Extent of establishment of eco-industrial information platform	%	100
	4.2	Environmental report release per year	issue/year	1
	4.3	Implementation of cleaner production audit in heavy pollution enterprises	%	100
	4.4	Extent of public satisfaction with local environmental quality	%	≥ 90
	4.5	Extent of public awareness degree with eco-industrial development	%	≥ 90

- **The Circular Transformation of Industrial Parks** was initiated in 2001. In 2005 the NDRC assumed management of the program and reinforced cooperation with the MEP, the Ministry of Science and Technology, the Ministry of Industry and Information Technology, the MoF, the MofCOM and the National Bureau of Statistics. This program is run at three different levels: firm, industrial park and regional. At the industrial park level, the goal is to develop participating zones through a circular economy pattern. In 2008 the financial crisis is thought to have played a role in the temporary slowdown of this program. In 2012, as the 12th FYP began, the NDRC and the MoF initiated a new demonstration program named the Circular Transformation of Industrial Parks (CTIP) (NDRC & MoF, 2012). While the name differs from the CEPZ, it is considered its successor.

Figure 2: Indicators from the CEPZ/CTIP programme at the industrial park level (Source: IISD, 2015: 8-9)

DIMENSIONS	NO.	INDICATORS	UNIT
Resource output indicators	1.1	Output rate of main mineral resources	
	1.2	Output rate of land	RMB/km ²
	1.3	Output rate of energy	RMB/tce
	1.4	Output rate of water	RMB/m ³
Resource consumption indicators	2.1	Energy consumption per unit of production value	tce/RMB
	2.2	Energy consumption per unit of production in the key industrial sector	tce/RMB
	2.3	Water consumption per unit of production value	m ³ /RMB
	2.4	Water consumption per unit of production in the key industrial sector	m ³ /RMB
Integrated resource utilization	3.1	Utilization rate of industrial solid waste	%
	3.2	Recycling rate of industrial wastewater	%
	3.3*	Disposed natural resources	Ton
Waste generation indicators	4.1	Industrial solid-waste disposed	Ton
	4.2*	Industrial solid-waste handled	Ton
	4.3	Industrial wastewater discharge	Ton
	4.4	SO ₂ emissions	Ton
	4.5	COO emissions	Ton
	4.6*	Ammonia emissions	Ton
	4.7*	Ammonia compounds	Ton
	4.8*	Carbon dioxide emissions per unit of GDP	ton/RMB
Others	5.1*	Association degree of the industrial zone	%
	5.2*	Share of non-fossil fuels in primary energy-consumption	%
	5.3*	Share of renewable energy	%

- **The Low-Carbon Industrial Park Program** was launched in September 2013 as a joint project of the MIIT and the NDRC to accelerate China's movement toward low-carbon industries and increase its industrial competitiveness by supporting innovation, upgraded technology and enhanced carbon management. A pilot experiment ran from 2014 to 2016 with 55 zones selected from a two-round process: they were first recommended by the provincial branches of the MIIT and the NDRC, and then verified and approved by the national level authorities. The official objective was to establish 80 pioneering zones by 2015. The experience gained during this pilot phase is to be used to help industries under MIIT's scope to improve their low-carbon practices and performances.

Indicators and measurements: The different indicators used to assess the environmental and economic performance of industrial zones can be sorted into five main categories across these schemes:

- land and population,
- material consumption,
- energy and emissions,
- pollution,
- administration and management.

The EIP metric system is considered by IISD (2015) the most complete, with indicators within all the categories. The Circular Economy zone indicators focus on waste/water reuse and recycling, as well as energy consumption, but lack information on pollution and management practices.

Industrial Zone NÖ-Süd, Austria (UNIDO, World Bank & GIZ, 2017: 66-67)

IZ NÖ-Süd was established in 1962 and is located in the Lower Austria Province, Austria. The park covers 280 hectares and comprises 370 companies. The companies located in the industrial park are mostly comprised of Small and Medium Enterprises (SMEs) and international companies that mostly rent the facilities for office, storage and production space purposes. While the example is taken from a European country, the scheme does highlight the pivotal role played by park management in the implementation of environmental standards.

Park management and governance structure: The industrial park is managed by ecoplus, which is a private business holding company. The mandate of the industrial park ecoplus is to ensure added value for the region, create local jobs, and build sustainability for regional development. The core competence of ecoplus is the development and management of customised rental properties. However, to further create and ensure a productive environment for companies located in the industrial park, ecoplus has expanded its core competence by offering a variety of services.

EIP performance and impacts: Ecoplus provides a one-stop service representing a hub that connects institutions, public authorities and partners. It offers guidance from conceptualising a business idea to its financing. In this regard, ecoplus has handled 200 investment project requests, as well as the subsequent management of realised investment projects. Additionally, the park management supports tenant companies in dealing with local authorities/official channels for purposes of applying and obtaining operating permits and other issues.

Economic performance: Currently, ecoplus business park IZ NÖ-Süd employs around 11,000 people. The industrial zone has established a collaboration with local vocational schools in neighbouring municipalities (Biedermannsdorf, Guntramsdorf, Laxenburg and Wiener Neudorf). This collaboration is particularly beneficial in ensuring the recruitment and retention of highly-skilled labour. Ecoplus offers other economic core features, include the creation of business networks, the operation of conference and event facilities, and coordinating joint media efforts for companies and the industrial park. Additionally, ecoplus is addressing the issues of industrial development and environmental and social sustainability by collaborating with academia and joining dialogue platforms with businesses.

Environmental performance: ecoplus operates and provides a range of central infrastructure services for the park, including a central wastewater treatment plant, 17 km of access roads and bus routes, and rail connections and a freight station with the Austrian railroad (ÖBB). Further, ecoplus maintains 100,000 square meters of green space, shrubs and trees within the boundaries of the industrial parks. As such, it ensures a dedicated space for recreational areas and a positive landscaping image.

Social performance: An extensive social infrastructure provision exists in and around IZ NÖ-Süd. The industrial park offers ideal access to postal offices and custom services, restaurants, a business hotel, 2 small, on-site shopping malls, and Europe's biggest shopping mall (SCS), a private child care facility, and appropriate security system (video surveillance). Due to the size of the industrial park and frequent investor and business partner visits, ecoplus has established a well-designed navigation system to guide visitors through the industrial park. Furthermore, there are a lot of recreational activities adjacent to the industrial park for employees and local communities, including tennis courts and golf courses.

Ulsan Mipo and Onsan Industrial Park, South Korea (UNIDO, World Bank & GIZ, 2017: 68-70)

South Korea has progressively integrated EIPs into their industrial complex framework. Employing 2 million people and being responsible for US\$45 billion in exports, South Korea's industrial parks have implemented the EIP model since 2005. This has helped them transition into innovation-led industrial parks. The EIP model prompted firms to invest over US\$520 million (623.71 billion won) in energy efficiency, industrial symbiosis, waste management, and other eco-friendly investments. To date, this has helped firms save over US\$554 million and generated US\$91.5 billion in new revenue. As of December 2014, 60.6% of South Korea's companies were managed by the Korea Industrial Complex Corporation (KICOX), which accounts for 52.5% of the country's employment, 54.5% of production, and 49.4% of exports.

Ulsan was designated as a special industrial zone in 1962 through the first 5 years of the national economic development plan that subsequently developed into the industrial capital of South Korea. The Ulsan Mipo and Onsan industrial park encompasses an area of 6,540 hectares, in which 1,000 companies operate. The park includes a variety of industries (e.g. vehicle manufacturing, shipbuilding, oil refineries, machineries, non-ferrous metals, fertiliser and chemical industries). Industries employ more than 100,000 people. The main objective of the Ulsan EIP initiative was to transform the Mipo-Onsan conventional national industrial complexes into sustainable EIPs based on the national eco-industrial park development master plan.

Park management and governance structure: The overall execution of the national EIP initiative is implemented by the KICOX, a semi-governmental body that manages national industrial complexes. It handles overall planning, budget accounting, approval of project proposals, and liaison with governmental bodies and concerned organisations. The Ulsan regional EIP centre is interested in the industrial symbiosis (IS) project development activities with regard to the local context. It is led by an advisory board composed of representatives from the local government, academia and industry. They also provide assistance for project development, proposal writing, providing follow-up actions for existing projects, and coordinating with local authorities and related organisations.

Economic performance: The economic benefits were calculated as the sum of cost savings (resource procurement, operations, and environmental/waste management by replacing virgin materials with by-products) and revenues (revenues generated by selling by-products) which were annually reported to KICOX since operations began. The government investments have totalled a US\$ 14.8 million for the project research and development, including centre operations. From this government research fund, new income of US\$ 65 million/year has been generated from selling by-products and waste for recycling purposes. An additional income of US\$ 78.1 million/year was generated from energy and material savings in 2016.

Environmental performance: The environmental benefits were evaluated in terms of the direct reduction of energy consumption, as well as a reduction in the generation of waste or by products, wastewater, and CO₂ emissions. From an environmental perspective, the Ulsan EIP program saved 279,761 tons of oil equivalent in energy use. This resulted in a reduction of 665,712 tons of CO₂ emissions and 4052 tons of toxic gases, such as SO_x and NO_x, during 2005-2016. In addition, a total of 79,357 tons of water and 40,044 tons of by-products and waste were reused. Consequently, this improved the negative image of the industrial complexes as pollution emitters, and enhanced relations with the neighbouring local communities.

Social performance: A total private investment for the construction of industrial symbiosis networking facilities amounted to US\$ 245.8 million (as of 2016), and created 195 new jobs.

Hoa Khanh Industrial Zone, Vietnam (UNIDO, World Bank & GIZ, 2017: 71-72)

The Hoa Khanh Industrial Zone (IZ) was established in 1996 by the Da Nang Administrative Committee. It belongs to the Lien Chieu District in Da Nang City. The park covers 396 hectares and comprises 168 companies. Resident firms operate their business through leasing contracts. Under its current investment strategy, Hoa Khanh IZ focuses on industries including: mechanics; assembly; food and seafood processing; forest products processing; construction materials; and electronics etc.

Park management and governance structure: The park is managed by the Da Nang Industrial Zones and Export Processing Authority, which is an administrative organisation that belongs to the Da Nang People's Committee. The authority directly monitors the planning, investment, labour, security, and environmental issues within industrial zones in Da Nang.

UNIDO provides support to the industrial park, focusing on the scaling-up of the park management capacity through dedicated training sessions, expert group meetings and study tours. The aim of these activities is to transfer the knowledge of existing international good practice examples. Currently, the park management has a functioning monitoring system in place. However, it does not yet provide for centrally-managed services.

Economic performance: In November 2015, the Hoa Khanh IZ reported accommodating 73,215 employees, of which 99% were domestic SME workers. Currently better career development programs can be found in international companies rather than in domestic SMEs.

Environmental performance: The current UNIDO project is targeting companies in the park to increase their environmental performance and resource efficiencies. The Vietnam National Cleaner Production Centre (VNCPC) has so far conducted resource efficient and cleaner production (RECP) assessments with 20 companies. The implementation of RECP options proposed under the project by the VNCPC achieved annual savings of Vietnamese dong (VND) 11.34 billion (equivalent to US\$ 500,000). Further, these assessments have saved 2,571 tons of solid waste, 1,034,300 kWh of electricity, and 6,000 kilolitres of water per year.

Since 2007, the centralised wastewater treatment plant is operating with an overall capacity of 5,000m³/day. It applies chemical-biological technology, and is managed by the Central Branch of Hanoi Urban Environment Company (URENCO). The biological treatment was assessed as relatively efficient, resulting in a reduced chemical consumption rate and chemical sludge generation. However, the volume of the wastewater treated is, on average, exceeding the capacity limit by 40%.

Every company located in the IZ must contract with the Da Nang URENCO for waste collection and treatment services. According to a study conducted under the UNIDO project, the total volume of waste amounts to 3,600 tonnes/month (94 percent is industrial waste), of which 55 percent is landfilled. Due to the absence of an IZ strategy on waste reuse and recycling, companies in the park mostly rely on the use individual contracts for their waste disposal.

Social performance: Essential social infrastructure provision exists in the immediate vicinity of the Hoa Khanh IZ, and includes local shops and banking facilities. Employees of the companies located in the IZ use private vehicles due to the lack of public or collective park transportation.

Working conditions generally follow national standards. However, SME standards do not often match the same standards as those of international companies. Although most enterprises have equipped their workers with sufficient personal protective equipment and occupational health training, occasionally, incidents and accidents still happen.

Izmir Ataturk Organized Industrial Zone, Turkey (UNIDO, World Bank & GIZ, 2017: 73-75)

Established in 1990, the Izmir Ataturk Organised Industrial Zone (OIZ) is located in Western Turkey, in Ciğli County of the İzmir Province. The OIZ is currently seeking opportunities to transition to an EIP framework. The OIZ is owned and operated by the Izmir Ataturk Organised Zone Authority. It comprises 556 tenants, and operates at a 100% occupancy rate across an area of 6,239,756 square meters (m²). The park is a mix of sectors, with the largest sectors being machinery-metal casting; plastics; food and beverages; textiles and ready-made clothing; and chemicals.

Economic performance: The industrial zone supports 37,500 employees. Approximately 75% of the firms export their products, with the majority going to the European Union (EU). Total annual turnover of the firms is US\$ 7.8 billion and total annual exports of the firms are valued at US\$ 2.5 billion. The total annual imports amount to US\$ 1 billion. Increased competitiveness can be achieved through lower operational costs at the firm level through energy and water efficiency upgrades. Across seven energy intensive sectors there is potential to save, as follows:

- 2,200 MWh/year through the upgrading of electricity motors;
- 16,100 m³ of water and 644,000 kWh of electricity annually, with a payback period of c. 1 year. This can be achieved by employing continuous washing with counter-current water/textile flow after dyeing and printing operations;
- 5 MWh annual energy efficiency savings with a payback period of c. 0.2 years. This can be achieved by installing additional automated metering and monitoring of electricity, fossil fuel and/or thermal energy consumption; and
- 5,000 MWh of electricity annually within the zone with an estimated payback period of c. 1.4 years. This can be achieved through the optimisation of chilled water systems (for process support) across 5 key sectors.

Environmental performance: The OIZ is TS EN ISO 90001 and TS EN ISO 14001 certified, and has environmental and energy management units within its organisational structure, as well as a three full-time personnel.

The environmental management unit is responsible for operations, maintenance and retrofitting of wastewater, storm water, water supply networks and a wastewater treatment plant. Periodic audits are carried out by this unit, and corrective measures are put into place. The environment unit has its own laboratory measuring wastewater treatment plant inlet/outlet quality parameters. The energy management unit is responsible for monitoring the energy facilities owned by the zone authority. Upon request, 'energy walkthroughs' are conducted by the unit for the tenants. It

also organises periodic sessions to raise awareness about energy efficiency improvement interventions among tenants.

The Wastewater Treatment Plant (WWTP) is owned and operated by the management team, and consists of two parallel facilities with the capacities of 12,000 m³/day and 9,000 m³/day. The OIZ goes beyond the national discharge standard, and holds the most stringent discharge parameters compared to other OIZs in Turkey. The head of the OIZ is directly responsible for meeting these standards. Within the WWTP, the sludge formed after treatment process is stored on site at a dedicated sludge drying beds unit, where the drained water from the sludge is cycled back to the WWTP. The dried sludge is eventually sent to the municipal landfill. One hundred percent of the firms are obliged to connect to the WWTP system.

The OIZ sources its water needs from the municipality water supply network. Rainwater and wastewater are collected separately through a 75 km-long storm water drainage system and a 45 km-long wastewater line.

The zone owns and operates a natural gas-fuelled 120 MW combined cycle power plant. There is also a 500 kW Solar photovoltaic (PV) plant (owned by OIZ management), with an average of 780,000 KWh in annual electricity generation.

A private company operates a plastic recycling facility on site. The tenants periodically report their solid waste volume to the Ministry of Environment and Urbanisation. Hazardous waste is transferred to and disposed of by mutual agreements with waste management companies.

Social performance: The OIZ owns a Private Technical College, which accommodates 285 students, offering 100% scholarship opportunities for eligible students. The OIZ also owns and operates a vocational training centre, a sports centre, a dispensary, and a kindergarten. The OIZ has enhanced its security by employing a smart camera system, and works in partnership with the İzmir Police Department. The OIZ organises sectoral workshops, R&D competitions, and informative seminars and carries out university-industry cooperative activities. OH&S are governed by national regulations, although there is currently no obligation to be certified under Occupational Health and Safety Assessment Series (OHSAS).

ALEAP Green Industrial Park in Telangana, India (UNIDO, World Bank & GIZ, 2017: 76-78)

The Association of Lady Entrepreneurs of India (ALEAP) (now known as the Association of Lady Entrepreneurs of Andhra Pradesh) is a national level organisation, with the objective of uplifting and empowering women through the establishment of small and medium enterprises. Given the paucity of government-funded industrial parks for women, ALEAP raised funds develops industrial parks exclusively for women entrepreneurs.

GIZ provided technical support to ALEAP for site master planning of the ALEAP Green Industrial Park (A-GRIP) project. It is located at Nandigama, near Hyderabad of the Telangana State, and caters to women entrepreneurs. A-GRIP covers an area of 334,094 m² (82.55 acres). It contains a total of 170 women entrepreneurs. For site master planning, many criteria were considered. These relate to economic, social, environmental, gender and resource efficiency issues. These considerations have now been integrated into the planning of the industrial park, and rely on benchmarks set by the German Sustainable Building Council (DGNB).

Measures for economic performance

- Services such as waste and wastewater management are proposed to be tendered based on appropriate business models and green procurement principles.
- Services such as manning entry/exits, security, and so on are to be outsourced.
- Infrastructure such as weigh-bridges, warehouses, commercial areas, and parking areas are to be leased through a tender process.
- The sale value of allocable land is within market rates (Indian rupee [INR] 1,170 per m², that is, US\$ 18.5 per m²), and investments are targeted for a total of INR 377.5 million, or US\$ 5.9 million.

Measures to ensure environmental performance

- Prevention of soil contamination and surface water pollution.
- Storm water management systems, including collection, treatment, and recycle/reuse to prevent pollution/contamination risks to surface/ground water.
- Wastewater management system, including tertiary treatment for recycle/reuse to prevent pollution/contamination risks to soil and surface/ground water.
- Biological and chemical water quality: Decentralised wastewater treatment systems with tertiary treatment to prevent any bacteriological or chemical contamination.
- Eco-efficient mobility with battery-operated vehicles, compressed natural gas (CNG) buses for internal/external transport, bicycling tracks, and pedestrian pathways. Vermi-compost plant, handmade paper unit, and a recycling centre for the recycling of wastes.
- Waste management systems.

Measures to ensure social performance:

- Special provisions for women employees, including play schools and crèches for infant children of workers, ladies' restrooms, and accommodations for late working hours.
- Safety and security.
- Internal and external transportation, including an internal, battery-operated shuttle service.
- Health centre, cafeterias/food outlets, and kiosks.
- Training centre and vocational training for local communities to create employment opportunities.
- Opportunities for nearly 200 women entrepreneurs and 10,000 employees, including employment for local communities.

4. Organisations supporting environmental standards for industrial parks

A variety of organisations provided support for the development of environmental safeguards in industrial parks. The most prominent of these are UNIDO, the World Bank and GIZ.

UNIDO, World Bank & GIZ I (Eco-Industrial Parks)

<https://www.unido.org/news/partners-launch-new-framework-eco-industrial-parks>

The concept of Eco-Industrial Parks (EIPs) has increasingly been recognised as an effective tool to overcoming challenges related to inclusive and sustainable industrial development within the scope of Sustainable Development Goals (SDGs). Countries such as Denmark, France, Japan and the Republic of Korea, among many others, have leveraged key elements of the EIP concept to promote more inclusive and sustainable action to improve industrial competitiveness in line with climate change goals.

An important element of the EIP approach is to create a more sustainable operating environment for firms, and to ensure that they are able to improve their competitiveness and create jobs. These eco-industrial parks would be designed to use resources more efficiently, and improve productivity. They would provide investors with an environment specifically adapted to support the achievement of their social responsibility goals. They would also increase market access to sustainable products, and lower exposure to climate change risks. Additionally, eco-industrial parks will contribute to the attainment of the Paris Climate Change Accord's Nationally Determined Contributions at the country level.

The EIP framework contains prerequisites and performance requirements. These are international and inclusive in scope, and are aimed at all industrial parks (including Special Economic Zones, Investment Zones, Industrial Estates, Industrial Parks, Manufacturing Zones, and so on). They also pertain to stakeholders in the private and public sectors wherever these industrial parks are located. The EIP framework describes the performance requirements for EIP centres according to four key categories: park management performance, environmental performance, social performance, and economic performance.

GIZ (Sustainable Industrial Areas) <https://www.sia-toolbox.net>

GIZ, promotes the idea of “Sustainable Industrial Areas” (SIA). Industrial areas are a motor of industrialisation and technology development worldwide. At the same time, they are often criticised as areas of ex-tended resource consumption and environmental pollution. The concept of “Sustainable Industrial Areas (SIA)” answers to this criticism by balancing economic, ecological and social aspects in industrial areas. This requires in particular management structures, which focus on resource and energy efficiency, environmental protection and social compatibility. The idea of “Sustainable Industrial Area” reflects this orientation and includes social aspects next to organisational, environmental and economical features as an indispensable requirement for a park on its pathway to sustainability.

For GIZ the concept of “Sustainable Industrial Areas” represent an important element of its advice to partners in the industrial sector. For many years, projects addressing various aspects of sustainable industrial development and sustainable industrial areas have been carried out by GIZ in many countries and significant knowhow and experiences have been accumulated in the organisation. The representatives of SIA projects and experts involved have formed the GIZ-working group on Sustainable Industrial Areas (SIA), which, together with its partners worldwide, permanently works on further developing the SIA concept.

UNIDO (Eco-Industrial Parks) <https://www.unido.org/our-focus/safeguarding-environment/resource-efficient-and-low-carbon-industrial-production/eco-industrial-parks>

One of UNIDO's contributions to the Sustainable Development Goals is facilitating the establishment of eco-industrial parks. An eco-industrial park is a community of businesses located on a common property. Members seek enhanced environmental, economic and social performance through collaboration in managing environmental and resource issues, and thus, seeking opportunities, and eventually engaging in industrial symbiosis activities within or outside the eco-industrial park.

Industrial symbiosis means that traditionally separate industries look for means and ways to gain competitive advantage through physical exchange of materials, energy, water and by-products, hence fostering inclusive and sustainable development.

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This report is based on five days of desk-based research. The K4D research helpdesk provides rapid syntheses of a selection of recent relevant literature and international expert thinking in response to specific questions relating to international development. For any enquiries, contact helpdesk@k4d.info.

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6. Annex

Steps toward transforming an existing economic zone into a Low-Carbon Zone (Source: World Bank, 2014: 18)

Steps	Activities	To be carried out by
1 Secure Commitment	<ul style="list-style-type: none"> ▶ Assess the political economy of low-carbon development ▶ Identify stakeholders and assess stakeholders' needs ▶ Establish organization and leadership ▶ Create a vision statement 	<ul style="list-style-type: none"> ▶ Zone authorities/ developers in association with national/regional governments
2 Technical Diagnostic	<ul style="list-style-type: none"> ▶ Conduct GHG inventory and forecasting ▶ Conduct energy audit and energy survey ▶ Establish a zone-level baseline ▶ Identify potential GHG mitigation projects ▶ Assess business case and prioritize projects 	<ul style="list-style-type: none"> ▶ Enterprises in the zones (through appointment of consultants and sectoral experts)
3 Set Targets	<ul style="list-style-type: none"> ▶ Establish different emission scenarios ▶ Set the target-GHG reduction based on the timeline ▶ Develop consensus around the possible target and its achievement 	<ul style="list-style-type: none"> ▶ Zone authorities/ developers based on outcomes of Step 2
4 Planning & Implementation	<ul style="list-style-type: none"> ▶ Develop detailed plan for project implementation ▶ Project content ▶ Scheduling ▶ Technology and vendor selection ▶ Financing needs ▶ Training and manpower needs ▶ Identify financing mechanisms ▶ Identify institutional and organizational needs ▶ Strengthen institutions ▶ Roll out projects 	<ul style="list-style-type: none"> ▶ Enterprises in the zones (through appointment of consultants and sectoral experts) ▶ Zone authorities/ developers in association with national/regional governments
5 Monitoring & Reporting	<ul style="list-style-type: none"> ▶ Develop GHG monitoring and tracking tool ▶ Collect information from enterprises and projects ▶ Develop stakeholder reporting structure ▶ Publish/circulate report 	<ul style="list-style-type: none"> ▶ Zone authorities/ developers and enterprises in the zones